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SMART BREATH ANALYSER ASTHIMA& COPD DETECTION SYSTEM USING IOT

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ABSTRACT

Smart Breath Analyzers were developed as sensing terminals of a telemedicine architecture devoted to remote monitoring of patients suffering from Asthma, Chronic Obstructive Pulmonary Disease (COPD) and home-assisted by non-invasive mechanical ventilation via respiratory face mask. The devices based on different sensors (Gas, Smoke Sensor and Volatile Organic Compounds (VOCs), relative humidity and temperature (R.H. & T) and Heart rate, respiration sensors) monitor the breath air exhaled. The system uses multiple sensors, including a heart rate sensor, temperature sensor, respiration sensor, gas sensor, sound sensor, humidity sensor, and smoke sensor, to collect real-time data on the user's respiratory health status. This data is then transmitted to an IoT cloud server, such as the Cayenne cloud server, for remote monitoring and management. The sensor raw signals are transmitted to National Health Service units / Doctor by TCP/IP communication through a cloud remote platform using IoT module. The work is a proof-of-concept of a sensors-based IoT system with the perspective to check continuously the effectiveness of monitoring and/or any state of exacerbation of the disease requiring healthcare. By a gas-mixing bench towards gas, smoke in environment and acetone concentrations in exhaled breath collected in a sampling bag were carried out to test the realized prototypes. This system uses analyze the data and detect early warning signs of Asthma and COPD attacks before they occur.

Keywords: COPD, Spirometry, lung inflammation and capnography.

1. INTRODUCTION

E-Health systems, together with smart sensor devices that allow real-time monitoring of relevant clinical parameters at home, are considered a promising approach to the prevention and treatment of respiratory diseases. Although the respiratory rate is a vital sign of special importance in the context of the monitoring and follow-up of respiratory diseases, especially to avoid dangerous situations in critically-ill patients, it is still considered as the most neglected vital sign. However, it could indicate a variety of pathological conditions in respiratory diseases, like COPD or sleep apnea, but also in cardiovascular and metabolic disorders. The respiratory rate has been used to anticipate dangerous events such as cardiac arrest, to classify patients in intensive care units and to predict complications or exacerbations in patients with cardiopulmonary diseases. It is an essential parameter for the monitoring of postoperative patients and for the detection of apnea or hypopnea events in pathologies related to sleep disorders. Wearable Health Devices (WHDs) are increasingly helping people to better monitor their health status both at an activity/fitness level for self-health tracking and at a medical level providing more data to clinicians with a potential for earlier diagnostic and guidance of treatment. The technology revolution in the miniaturization of electronic devices is enabling to design more reliable and adaptable wearables, contributing for a world-wide change in the health

monitoring approach. In this paper we review important aspects in the WHDs area, listing the state-of-the-art of wearable vital signs sensing technologies plus their system architectures and specifications.

Spirometry and capnography are the common techniques used for the monitoring of respiratory rate but they represent an uncomfortable experience for the subject, disturbing the natural breathing; hence, they are not suitable for long-term application. However, many of the proposed developments have the drawback of special sensor placement location, many times uncomfortable, or require thorough signal processing that severely impacts battery lifetime. In addition, they do not have an accuracy comparable to that obtained by the obstructive methods (spirometry and capnography), even in experiments at rest. From the point of view of communications, the rapid adoption of the Internet of Things (IoT) paradigm in different technological ecosystems is also having a significant impact on health information services, particularly on e-Health systems. In this sense, IoT is a concept that refers to the interconnection through the Internet of computing devices embedded in everyday objects. These objects are physical elements with communication capability and programmable logic, including mainly sensor devices and actuators. In the field of e-Health, the Internet of Medical Things (IoMT) paradigm is managing the technological transition from the traditional centralized systems, where the patient is considered as a passive element, towards patient-centered ecosystems and highly mobile environments. The ubiquitous nature of IoT enables the distribution of data between all communication entities, regardless of the underlying network topology, geographic location, type of device used or technological platform deployed. Real-time communications support, Quality of Service (QoS) policies and the publisher/subscriber-based communication pattern are some advantages of the IoT paradigm, which represents an added value in e-Health systems to overcome some technological barriers that have limited the deployment of these types of systems. The IoT facilitates the communication and cooperation between systems and the parametrization and filtering of data handled. This allows the establishment of thresholds on the different types of data considered, thus also simplifying the management of alarms.

Health management and monitoring platforms integrated with the IoT technologies paradigm can further increase the intelligence, flexibility, scalability and interoperability of these systems. For continuous respiratory monitoring, numerous sensorization technologies have been proposed. Chronic Obstructive Pulmonary Disease (COPD) affects 12–16 million people in the United States and is the third leading cause of death. The prevalence and mortality of COPD is expected to increase in the coming decades. COPD is characterized by symptoms of wheeze, shortness of breath and cough. In addition, intermittent exacerbations of disease often change the trajectory of disease course, leading to worse health related quality of life, hastened lung function decline, reduced functional capacity and increased risk of death. The World Health Organization (WHO) estimates that ambient air pollution is responsible for 3.7 million premature deaths worldwide in 2012 and 14% of these deaths were due to COPD or acute lower respiratory infections. Integrated exposure-response modeling suggests that the population attributable mortality risk due to ambient air pollution for COPD varies and was estimated to range from < 1 to 21% depending on country. In particular, particulate matter (PM) which is a complex mixture of solid and liquid particles made up of a number of components [including acids, organic chemicals, metals and soil or dust particles]; nitrogen dioxide (NO₂), which is a gaseous product of high-temperature combustion [including emissions from automobiles, power plants and off-road equipment]; and ozone (O₃) which is a strong oxidizing agent with a variety of effects including lung inflammation, alveolar epithelial damage and changes in chemical composition of lung lavage fluid have been linked to COPD. In addition, there has been increased attention to the effects of heat exposure with the anticipated increases in temperature projected in the context of climate change. Extremes of temperature may affect COPD outcomes and may even modify the effects of pollutant exposure. Therefore, understanding the effects of air pollution and temperature on COPD is a crucial step to the development of preventative strategies and patient care.

2. LITERATURE SURVEY

SIÑAO SANTOS, SHUAI YANG ET AL "DESIGN AND CHARACTERIZATION OF A GRAPHENE-BASED FET FOR ULTRASENSITIVE DETECTION OF CLINICAL BIOMARKERS" – IEEE, 2019.

They have studied of material characteristics comprising a GFET, with perspective to detect biomarkers of COPD. They have researched of emerging materials such as graphene monolayer and perovskite may revolutionize the field of point-of-care devices. These materials can boost the sensitivity and specificity of the detection, and therefore the detection can be performed in samples taken non-invasively, such saliva, and with less sample quantity. A graphene field effect transistor (GFET)coated with PEDOT: PSS and perovskite, bring advantages to the photo detection field, due to the unique proprieties of 2Dmaterials and the structure of perovskite.

VISWAM NATHAN, KOROSH VATANPARVAR ET AL "ASSESSMENT OF CHRONIC PULMONARY DISEASE PATIENTS USING BIOMARKERS FROM NATURAL SPEECH RECORDED BY MOBILE DEVICES" – IEEE, 2018.

They have analyzed of passively recorded natural speech patterns. It has been previously established that diseases such as asthma and chronic obstructive pulmonary disease (COPD) affect pause patterns and prosodic features of speech. In this study we present an exploration of the feasibility of using speech features from natural speech to detect pulmonary disease. Experiments were conducted on a cohort of 131 subjects: 91 with asthma and/or COPD, and 40 healthy controls. Patients and healthy subjects were differentiable with 68% accuracy; moreover, the subset of patients with the highest disease severity were detected with 89% accuracy.

NEEMA MORAVEJI, PHIL GOLZ, ET AL "LONG-TERM, AMBULATORY RESPIRATORY MONITORING OF COPD PATIENTS USING GARMENT-ADHERED SENSORS" – IEEE, 2019.

They studied was designed to limit patient burden as much as possible. Each participant underwent an initial, web-based screening to assess their disease progression, willingness to wear the devices on their undergarments for 9 months, and report on weekly COPD-related symptom a web-based survey. They proceeded with a nurse interview and, if still eligible, received a pack of Health Tags in the mail. A phone-based technical support specialist optionally talked participants through the device setup procedure. Remote monitoring of de-identified device adherence and respiratory data was possible through a web-based dashboard. Participants were automatically notified by SMS, email, and ultimately manual phone calls if device adherence became a concern.

3. EXISTING SYSTEM

Breathing pattern has been shown to be different in chronic obstructive pulmonary disease (COPD) patients compared to healthy controls during rest and walking. In this study we evaluated respiratory parameters and the breathing variability of COPD patients as a function of their severity. Thoracic bio impedance was acquired on 66 COPD patients during the performance of the six-minute walk test (6MWT), as well as 5 minutes before and after the test while the patients were seated, i.e. resting and recovery phases. The patients were classified by their level of airflow limitation into moderate and severe groups. We characterized the breathing patterns by evaluating common respiratory parameters using only wearable bio impedance. Specifically, we computed the median and the coefficient of variation of the parameters during the three phases of the protocol, and evaluated the statistical differences between the two COPD severity groups

4. PROPOSED SYSTEM

Early disease detection and diagnostics are major areas of interest for health and disease management. The two most commonly used physical- and chemical-sensors in smart sensor systems are electronic chemical nose and wearable sensors. Nowadays, owing to population growth, increasing environmental pollution, and lifestyle changes, the number of asthmatics has significantly increased. Therefore, the purpose of our study was to determine the asthma-prone areas in India. In this proposed paper, we present an asthma and COPD risk alert through Internet of Things (IOT) and buzzer. Respiratory symptoms are common in early life and often

transient. It is difficult to identify in which children these will persist and result in asthma. Wearable sensors for measuring the environmental parameters of the atmospheric condition, there are a few cases to apply wearable biochemical sensors into the smart sensor systems. Wearable physical sensors are devices that are generally attached to the end-user to extract movement data, which are composed of heart beat sensor, respiration sensor, smoke sensor, gas sensor, temperature and humidity and PIC (16F877A) Microcontroller and LCD display. The proposed system is an IoT-based Smart Breath Analyzer for Asthma and COPD prediction using multiple sensors including a heart rate sensor, temperature sensor, respiration sensor, gas sensor, and smoke sensor. The system is designed to detect and predict the onset of Asthma and COPD attacks and automatically supply oxygen through an oxygen pump in case of any abnormalities.

5. METHODOLOGY

Our Proposed System builds a prototype consists of three modules i.e. Hardware Unit, Software Unit and IOT module. In Our prototype we going to predict an asthma / COPD patients by sensing the parameters like Temperature, Humidity, heart rate, Smoke, Gas and respiration of patients. Hardware Unit Consists of Sensors which integrated with PIC (16F877A) Microcontroller to fed the sensing data. Heart Rate Sensor: The heart rate sensor will measure the user's heart rate and detect any abnormal changes that may indicate an Asthma or COPD attack. Temperature Sensor: The temperature sensor will measure the user's body temperature, which can be used to detect fever, a common symptom of Asthma and COPD. Respiration Sensor: The respiration sensor will measure the user's breathing rate and detect any abnormalities in their breathing pattern. Gas Sensor: The gas sensor will measure the concentration of harmful gases such as carbon monoxide and nitrogen dioxide in the air. These gases can trigger Asthma and COPD attacks. Sound Sensor: The sound sensor will detect any cough or abnormal sounds in the user's breathing pattern that may indicate an Asthma or COPD attack. Humidity Sensor: The humidity sensor will measure the level of moisture in the air. High humidity levels can trigger Asthma and COPD attacks. Smoke Sensor: The smoke sensor will detect any smoke or pollutants in the air that can trigger Asthma and COPD attacks. The sensor analog and digital output values are fed to PIC controller, and then transmitted to IOT module (ESP 8266 – 12E NODE MCU). When coupled with IOT, such an electronic chemical nose can diagnose these types of diseases in a noninvasive, convenient, and economical manner compared with those of traditional method. The proposed IoT-based Smart Breath Analyzer for Asthma and COPD prediction system is a promising technology that has the potential to improve the lives of individuals with these conditions. The system will continuously monitor the user's health and provide early warning signs of Asthma and COPD attacks, allowing them to take preventive measures to avoid triggering an attack. The automatic oxygen supply feature of the system will help alleviate symptoms and reduce the severity of the attack. The system can be connected to the Cayenne cloud server to enable remote monitoring and management of the system. The Cayenne cloud server will allow the user to view realtime data from the sensors and receive alerts if any abnormalities are detected. The user can also automate actions based on sensor readings, such as activating the oxygen pump if an Asthma or COPD attack is predicted. This device used to increase the feasibility of the system by including the key concepts of IOT for user's accurate tracking of asthma / COPD abnormalities / complication in real time.

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6. HARDWARE REQUIREMENTS

Precise Rectifier Temperature Sensor Heart Beat Sensor Humidity Sensor Respiration Sensor Gas Sensor Sound Sensor Smoke Sensor Arduino Uno Iot Module Lcd Display USB TO UART Converter

7. SOFTWARE REQUIRED

MPLAB IDE – PIC Programming Software CAYENNE APP & Server – Iot Monitoring & Control PICKIT 2 – PIC Programmer Kit

8. RESULTS AND DISCUSSION

The IoT-based Smart Breath Analyzer for Asthma and COPD prediction system using multiple sensors and an oxygen pump has the potential to significantly improve the management and monitoring of respiratory diseases. In this section, we will discuss the detailed results and potential implications of the system. The system uses multiple sensors, including a heart rate sensor, temperature sensor, respiration sensor, gas sensor, sound sensor, humidity sensor, and smoke sensor, to collect real-time data on the user's respiratory health status. The data is then transmitted to an IoT cloud server, such as the Cayenne cloud server, for remote monitoring and management. The system uses machine learning algorithms to analyze the data and detect early warning signs of Asthma and COPD attacks before they occur. If an attack is predicted, the system can automatically supply oxygen through an oxygen pump to alleviate symptoms and reduce the severity of the attack. This can significantly improve the patient's quality of life and reduce the risk of complications. The system provides personalized treatment and care recommendations based on the user's health data, which can improve the effectiveness of the treatment and reduce the risk of complications. The system can also help reduce the frequency of hospitalizations and emergency room visits, leading to cost savings for both the patient and the healthcare system. The system has several advantages, including early detection, remote monitoring, real-time data collection, automatic oxygen supply, personalized treatment, and cost-effectiveness. It has a wide range of applications in healthcare, research, occupational health, sports, and fitness. the IoT-based Smart Breath Analyzer for Asthma and COPD prediction system using multiple sensors and an oxygen pump has the potential to significantly improve the management and monitoring of respiratory diseases. It has several advantages, including early detection, remote monitoring, real-time data collection, automatic oxygen supply, personalized treatment, and cost-effectiveness. The system has a wide range of applications in healthcare and other settings and can lead to better health outcomes and quality of life for individuals with Asthma and COPD.

9.CONCLUSION

Asthma and Chronic obstructive pulmonary disease is a progressive lung disease that causes shortness of breath and other breathing complications. Asthma and COPD causes hundreds of thousands of deaths, and if it is not diagnosed and treated at early stages, leads to premature death. Although several invasive approaches are available to diagnose COPD, they require pulmonologists for prediction. This study proposes the use of a non-invasive approach utilizing the machine learning techniques, which is used to predict the abnormalities such as breathing troubles early. Wearable vital signs enabled a broad range of wearable sensor application scenarios for asthma and COPD monitoring and management. The proposed IoT-based Smart Breath Analyzer for Asthma and COPD prediction system with the addition of the Cayenne cloud server is a powerful tool for managing and monitoring Asthma and COPD. The system will continuously monitor the user's health and provide early warning signs of Asthma and COPD attacks, allowing them to take preventive measures to avoid triggering an attack. The automatic oxygen supply feature of the system will help alleviate symptoms and reduce the severity of the attack, and the Cayenne cloud server will enable remote monitoring and management of the system.

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